4. (a) Eq. 36-3 and Eq. 36-12 imply smaller angles for diffraction for smaller wavelengths. This suggests that diffraction effects in general would decrease.

(b) Using Eq. 36-3 with $m = 1$ and solving for 2θ (the angular width of the central diffraction maximum), we find

$$2\theta = 2\sin^{-1}\left(\frac{\lambda}{a}\right) = 2\sin^{-1}\left(\frac{0.50\,\text{m}}{5.0\,\text{m}}\right) = 11^\circ.$$

(c) A similar calculation yields 0.23° for $\lambda = 0.010$ m.

6. (a) $\theta = \sin^{-1}$ (1.50 cm/2.00 m) = 0.430°.

(b) For the mth diffraction minimum $a \sin\theta = m\lambda$. We solve for the slit width:

$$a = \frac{m\lambda}{\sin\theta} = \frac{2(441\,\text{nm})}{\sin 0.430^\circ} = 0.118\,\text{mm}\ .$$

7. The condition for a minimum of a single-slit diffraction pattern is

$$a\sin\theta = m\lambda$$

where a is the slit width, λ is the wavelength, and m is an integer. The angle θ is measured from the forward direction, so for the situation described in the problem, it is 0.60° for $m = 1$. Thus,

$$a = \frac{m\lambda}{\sin\theta} = \frac{633\times10^{-9}\ \text{m}}{\sin 0.60^\circ} = 6.04\times10^{-5}\ \text{m}\ .$$

10. From $y = m\lambda L/a$ we get

$$\Delta y = \Delta\left(\frac{m\lambda L}{a}\right) = \frac{\lambda L}{a}\Delta m = \frac{(632.8\,\text{nm})(2.60)}{1.37\,\text{mm}}[10-(-10)] = 24.0\,\text{mm}\ .$$

13. (a) $\theta = \sin^{-1}$ (0.011 m/3.5 m) = 0.18°.

(b) We use Eq. 36-6:

$$\alpha = \left(\frac{\pi a}{\lambda}\right)\sin\theta = \frac{\pi(0.025\,\text{mm})\sin 0.18^\circ}{538\times10^{-6}\ \text{mm}} = 0.46\,\text{rad}\ .$$

(c) Making sure our calculator is in radian mode, Eq. 36-5 yields

$$\frac{I(\theta)}{I_m} = \left(\frac{\sin\alpha}{\alpha}\right)^2 = 0.93 \,.$$